Nora Loose

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Research Interests

Physical & computational oceanography, Ocean mesoscale eddy parameterizations, Machine Learning, Scientific software development, Uncertainty quantification, Adjoint modeling, Ocean observing system design

Education

01/2015 - 08/2019 **University of Bergen**, Bergen, Norway
Ph.D. in **Physical Oceanography**
- Thesis: *Adjoint Modeling and Observing System Design in the Subpolar North Atlantic*
- Advisors: Kerim H. Nisancioglu (University of Bergen), Patrick Heimbach (UT Austin)

04/2007 - 02/2013 **University of Bonn**, Bonn, Germany
Diploma (equiv. M.Sc. degree) in **Mathematics**, **with Honors**
- Specialization: Stochastic Analysis; Minor: Physics
- Grade Point Average: 1.0, on a scale from 1.0 (excellent) to 4.0 (pass)

Research Experience

10/2022 - present **Postdoctoral Research Associate**, *Program in Atmospheric and Oceanic Sciences*, Princeton University
- Member of the M2LInES project
- Apply machine learning methods to improve ocean mesoscale eddy parameterizations
- Mentors: Alistair Adcroft & Laure Zanna

10/2020 - 09/2022 **Postdoctoral Associate**, *Department of Applied Mathematics*, University of Colorado, Boulder
- Member of the Ocean Transport and Eddy Energy Climate Process Team
- Explored eddy energy cycles and parameterizations in isopycnal ocean models
- Developed open source software for spatial filtering of gridded geophysical data
- Mentor: Ian Grooms

09/2019 - 09/2020 **Postdoctoral Fellow**, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin
- Leveraged adjoint modeling and uncertainty quantification for ocean observing system design
- Mentor: Patrick Heimbach

1/2015 - 06/2018 **Graduate Researcher**, *Department of Earth Science*, University of Bergen, Norway
- Investigated oceanic teleconnections in the North Atlantic, Nordic Seas, and Arctic Ocean
- Quantified uncertainties in ocean state estimates for present-day and paleo climates

03/2013 - 08/2014 **Doctoral Research Fellow**, *Department of Mathematics*, ETH Zurich, Switzerland
- Conducted research in the fields of Geometric Analysis and Partial Differential Equations
- Assisted in teaching undergraduate and graduate level courses

Teaching and Outreach

02/2020 **Volunteer**, *Girl Day STEM Festival*, UT Austin
- Hands-on science activities and demonstrations for elementary and middle school students

2008 - 2014 **Teaching Assistant**

- for graduate and post-graduate level math course (*Weak immersions of surfaces with L^2-bounded second fundamental form*, lecture notes) at PCMI Graduate Summer School, USA (2013)
- for 3 graduate level math courses at ETH Zurich, Switzerland (2013 - 2014) with *teaching evaluations*: 4.8 (2013), 4.9 (2014) on a scale from 1 (very bad) to 5 (excellent)
- for 4 undergraduate level math courses at University of Bonn, Germany (2008 - 2013) and University of Toronto, Canada (2010)

Funded Grants

08/2021-07/2025 **NSF CSSI Grant**, *National Science Foundation*, $166,590

- Project: Collaborative Research: Frameworks: Convergence of Bayesian inverse methods and scientific machine learning in Earth system models through universal differentiable programming
- Role: Principal Investigator (Lead PI: Patrick Heimbach, UT Austin)

02/2016 **Research Grant**, *Norwegian Research School in Climate Dynamics*, NOK 20,000

- for research stay at MIT

Awards and Scholarships

2022 **Outstanding Reviewer Citation**, *for the AGU Journal JAMES (Journal of Advances in Modeling Earth Systems)*, American Geophysical Union (AGU)

04/2019 **Rising Stars in Computational & Data Sciences**, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin

- Selected for competitive, international career event for women in Computational & Data Sciences

03/2018 **Best Presentation Award**, *Research School on Changing Climates in the Coupled Earth System*, Sommarøy, Norway

02/2013 **Award "Diploma with Honors"**, *Department of Mathematics, University of Bonn, Germany*, for graduating with highest possible grade point average

2008 - 2012 **German Academic Scholarship Foundation Award**, *Studienstiftung des deutschen Volkes*, for outstanding academic achievements (given to 0.5% of students in Germany)

Mentoring

2022 - present **PhD Co-Advisor**
for graduate student Sarah Williamson at UT Austin

2021 - 2022 **Mentor**

- for a coding project as part of OceanHackWeek 2022
- for 4 students as part of the SOARS program, the PROGRESS mentorship program, and the ASLOMP mentorship program

Professional Service

Peer review service

Geophysical Research Letters, Journal of Advances in Modeling Earth Systems, Journal of Climate, Journal of Physical Oceanography, Journal of Open Source Software

Review of proposals

Panelist for reviewing NASA ROSES proposals

Organization of Conferences

02/2024 Co-Convener for the session "Advances in Data Science for Ocean Uncertainty Quantification", Ocean Sciences Meeting 2024.

08/2022 Co-Organizer of OceanHackWeek 2022.

02/2022 Co-Convener for the session "Mesoscale Eddy Energy and Ocean Transport", Ocean Sciences Meeting 2022.

Membership of Scientific Projects and Societies

09/2022 - present Working group "'NEMO working group on machine learning and model uncertainty"

Publications

Preprints

P1 **N. Loose**, G.M. Marques, A. Adcroft, S. Bachman, S.M. Griffies, I. Grooms, R.W. Hallberg and M. Jansen. Comparing two parameterizations for the restratification effect of mesoscale eddies in an isopycnal ocean model, *submitted to Journal of Advances in Modeling Earth Systems*, Preprint doi: 10.1002/essoar.10512867.1.

P2 S. Yu, ..., **N. Loose**, ..., M.S. Pritchard. ClimSim: An open large-scale dataset for training high-resolution physics emulators in hybrid multi-scale climate simulators, *submitted*, Preprint doi: 10.48550/arXiv.2306.08754.

Journal Arcticles

J7 **N. Loose**, S. Bachman, I. Grooms and M. Jansen. Diagnosing scale-dependent energy cycles in a high-resolution isopycnal ocean model, *Journal of Physical Oceanography*, doi: 10.1175/JPO-D-22-0083.1.

J6 G. Marques, **N. Loose**, E. Yankovsky, J. Steinberg, C-Y Chang, N. Bhamidipati, A. Adcroft, B. Fox-Kemper, S. Griffies, R. Hallberg, M. Jansen, H. Khatri and L. Zanna. NeverWorld2: An idealized model hierarchy to investigate ocean mesoscale eddies across resolutions, *Geoscientific Model Development 15, no. 17: 6567-79*, doi: 10.5194/gmd-15-6567-2022.

J5 **N. Loose**, R. Abernathey, I. Grooms, J. Busecke, A.P. Guillaumin, E. Yankovsky, G. Marques, J.M. Steinberg, A.S. Ross, H. Khatri, S.D. Bachman, L. Zanna, P. Martin. GCM-Filters: A Python Package for Diffusion-based Spatial Filtering of Gridded Data, *Journal of Open Source Software, 7(70), 3947*, 2022. doi: 10.21105/joss.03947.

J4 I. Grooms, **N. Loose**, R. Abernathey, J.M. Steinberg, S.D. Bachman, G. Marques, A.P. Guillaumin, E. Yankovsky. Diffusion-Based Smoothers for Spatial Filtering of Gridded Geophysical Data, *Journal of Advances in Modeling Earth Systems*, 13, e2021MS002552, 2021. doi: 10.1029/2021MS002552.

J3 **N. Loose** and P. Heimbach. Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems, *Journal of Advances in Modeling Earth Systems*, 13, e2020MS002386, 2021. doi: 10.1029/2020MS002386.

J2 **N. Loose**, P. Heimbach, H. Pillar and K.H. Nisancioglu. Quantifying Dynamical Proxy Potential through Shared Adjustment Physics in the North Atlantic, *Journal of Geophysical Research: Oceans 125, no. 9*, 2020. doi: 10.1029/2020JC016112. Selected as Eos Research Spotlight.

J1 Y. Fujii, E. Rémy, H. Zuo, P. Oke, G. Halliwell, F. Gasparin, M. Benkiran, **N. Loose**, J. Cummings, J. Xie, Y. Xue, S. Masuda, G.C. Smith, M. Balmaseda, C. Germineaud, D.J. Lea, G. Larnicol, L. Bertino, A. Bonaduce, P. Brasseur, C. Donlon, P. Heimbach, Y. Kim, V. Kourafalou, P-Y. Le Traon, M. Martin, S. Paturi, B. Tranchant and N. Usui. Observing System Evaluation Based on Ocean Data Assimilation and Prediction Systems: On-Going Challenges and a Future Vision for Designing and Supporting Ocean Observational Networks, *Front. Mar. Sci. 6:417*, 2019. doi: 10.3389/fmars.2019.00417.

Thesis

T1 **N. Loose**. Adjoint Modeling and Observing System Design in the Subpolar North Atlantic, *Ph.D. Dissertation*, University of Bergen, 2019. http://bora.uib.no/handle/1956/24456.

Selected presentations

5 Selected Talks

01/2023 **SOOS Observing System Design Capability Working Group (Invited)**, *Online*
Adjoint Models, Uncertainty Quantification, and Observing System Design

04/2022 **Ocean Sciences Meeting 2022**, *Online*
Diagnosing scale-dependent Lorenz and Bleck energy cycles in a high-resolution layered model

01/2022 **12th Symposium on Advances in Modeling and Analysis Using Python, AMS Meeting**, *Online*
GCM-Filters: A Python Package for Spatial Filtering Analysis of Gridded Data from Ocean and Climate Models (slides)

01/2022 **20th DRAKKAR Ocean Modelling Workshop (Invited Keynote Talk)**, *Online*
Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems

12/2021 **Ocean Circulation and Climate Dynamics Colloquium, GEOMAR Kiel**, *Online*
Oceanic teleconnections in the North Atlantic: From dynamical proxy potential to observing system design

Field Work

07/2017 - 08/2017 **East Greenland Ice-Core Project (EastGRIP)**, *Greenland*
- Drilled shallow ice cores, conducted surface measurements and lab work in the science trench

08/2016 - 09/2016 **G.O. Sars**, *Irminger Sea*
- Collected physical oceanographic data and marine sediment cores for the ice2ice project (ERC)

Technical Strengths

- **Computer Languages**: Python (xarray, dask, numpy, scipy), MATLAB, Fortran, shell scripting
- **Software Contributions**: GCM-Filters, ClimSim, MOM6, MITgcm
- **Visualization & Design**: Cartopy, Matplotlib, LaTeX, HTML
- **Data & Databases**: NetCDF, Zarr
- **Platforms**: HPC, JupyterLab, GitHub